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Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

13 March 2017

SPECS: Climate Prediction for Climate Services

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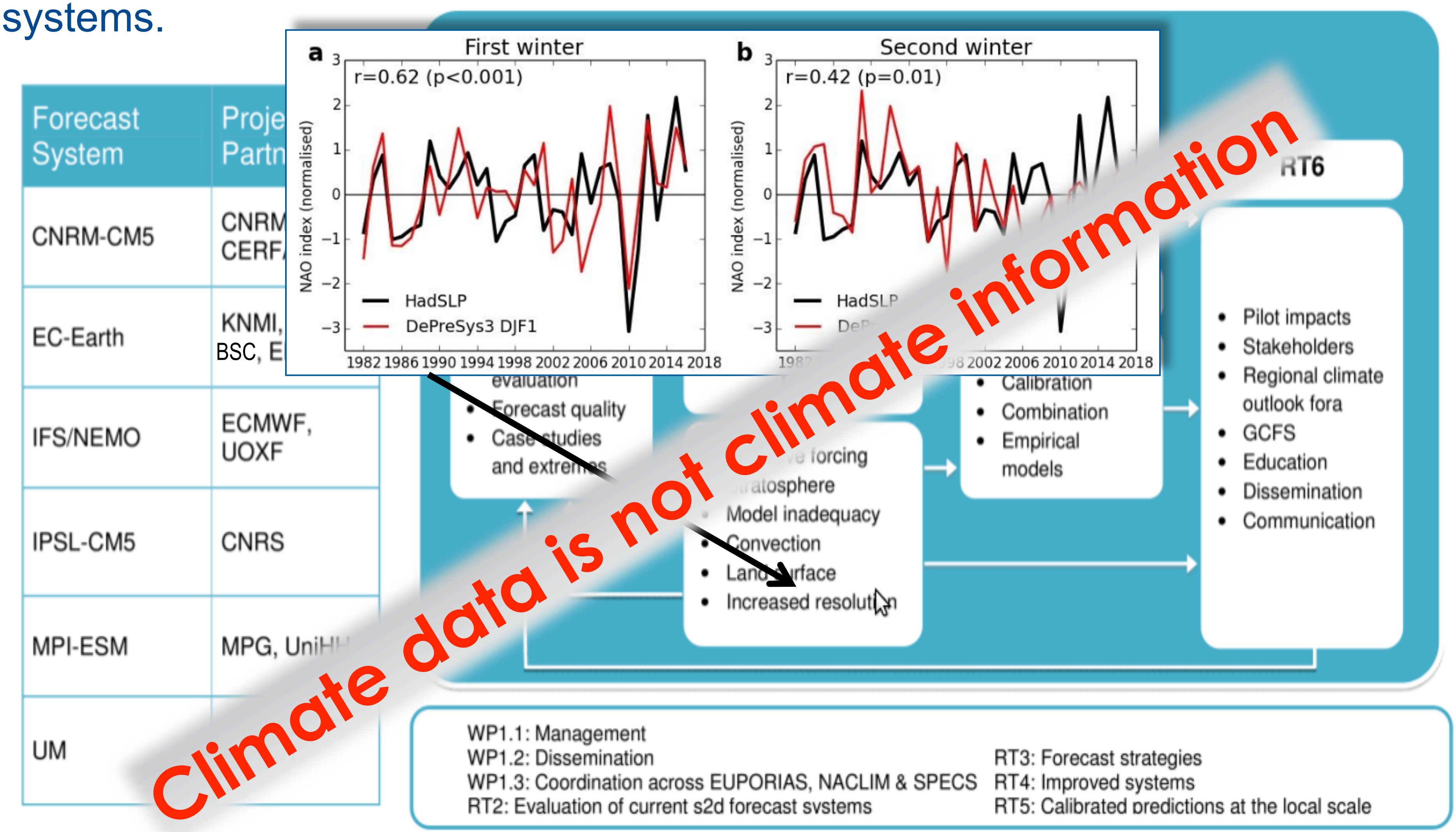
SPECS
Seasonal-to-decadal climate Prediction for the

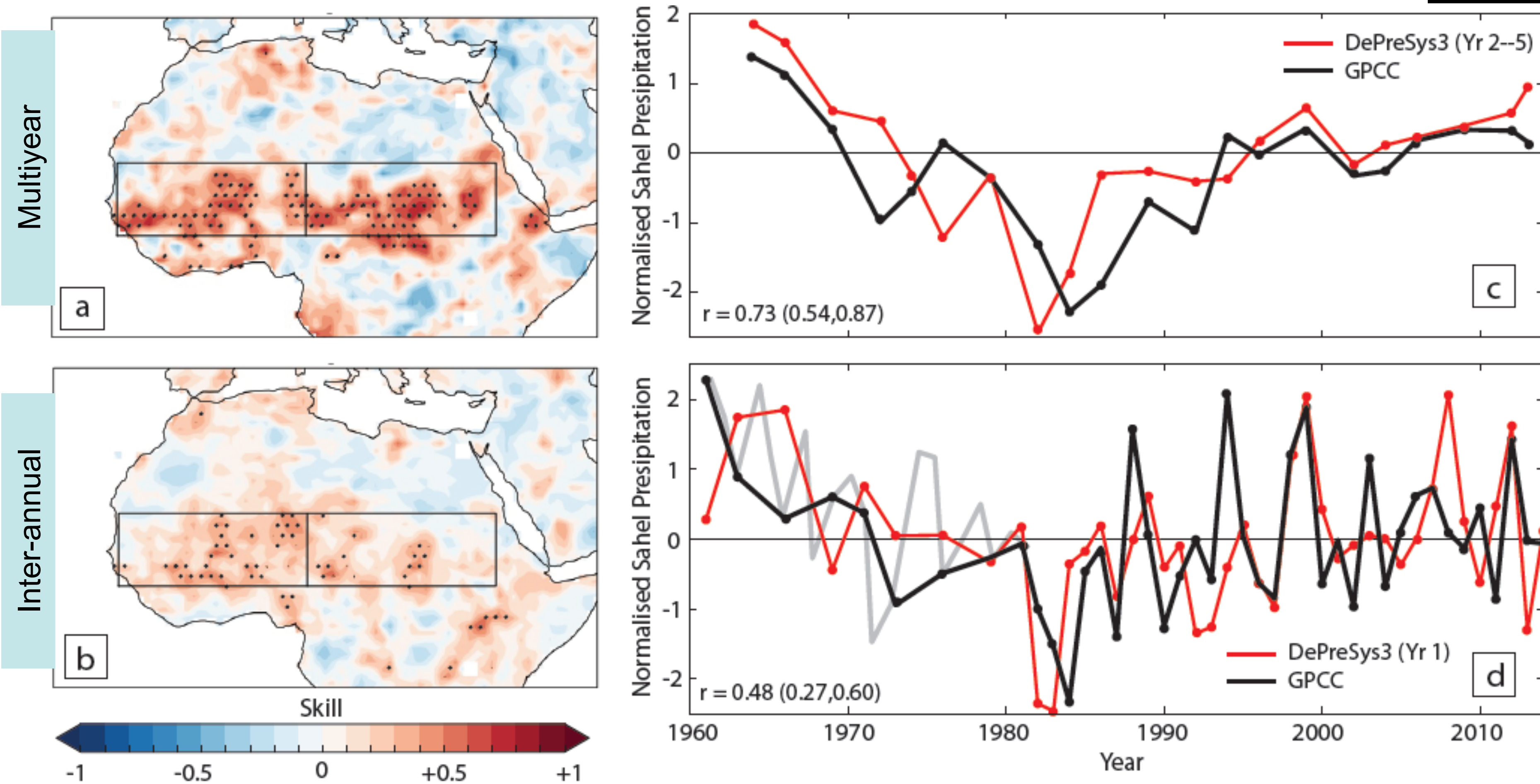
SPECS objective and structure

SPECS specs-fp7.eu produced quasi-operational and actionable local climate information with a new generation of reliable European climate forecast systems.



Resolution brings leap forward in skill

Correlation of the ensemble mean precipitation from DePreSys3 (N216-ORCA025).

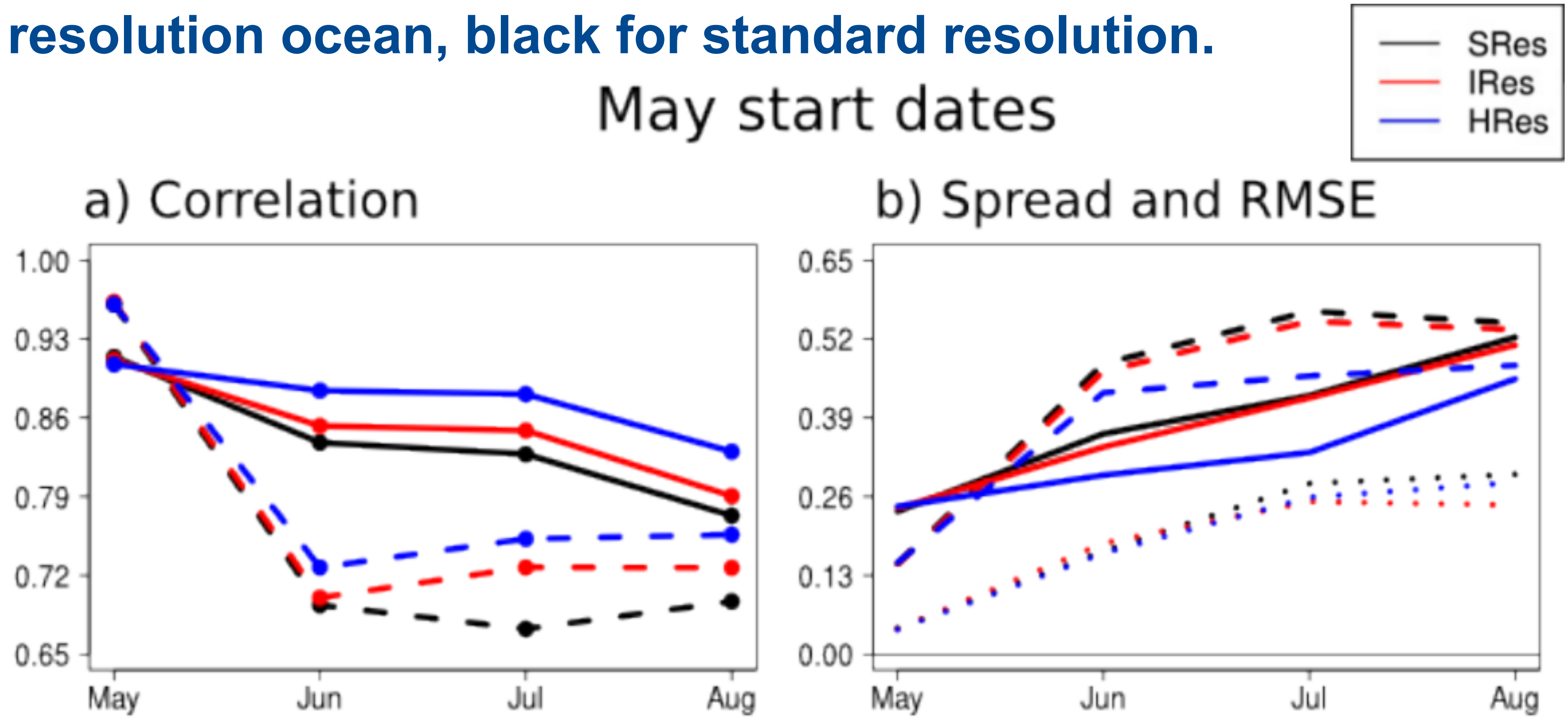


Sheen et al. (2017, J. Climate)

Increased resolution improves skill

Forecast quality from EC-Earth3.1 seasonal hindcasts (1993-2009, Glorys2v1, ERAInt and ERALand initial conditions). Solid for ESA-CCI and dashed for ERSST.

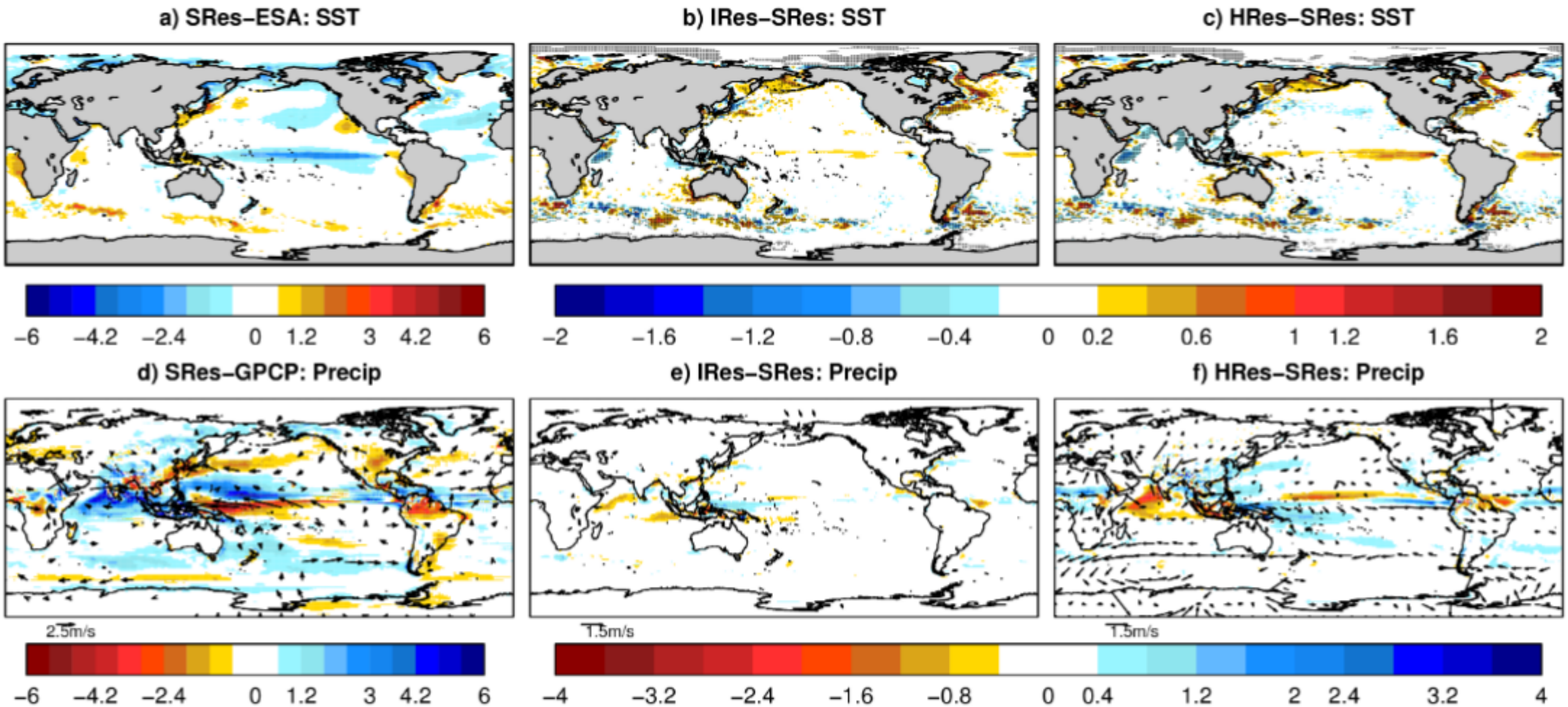
Blue for high resolution ocean and atmosphere, red for high resolution ocean, black for standard resolution.



Prodhomme et al. (2016, J. Climate)

Increased resolution modifies biases

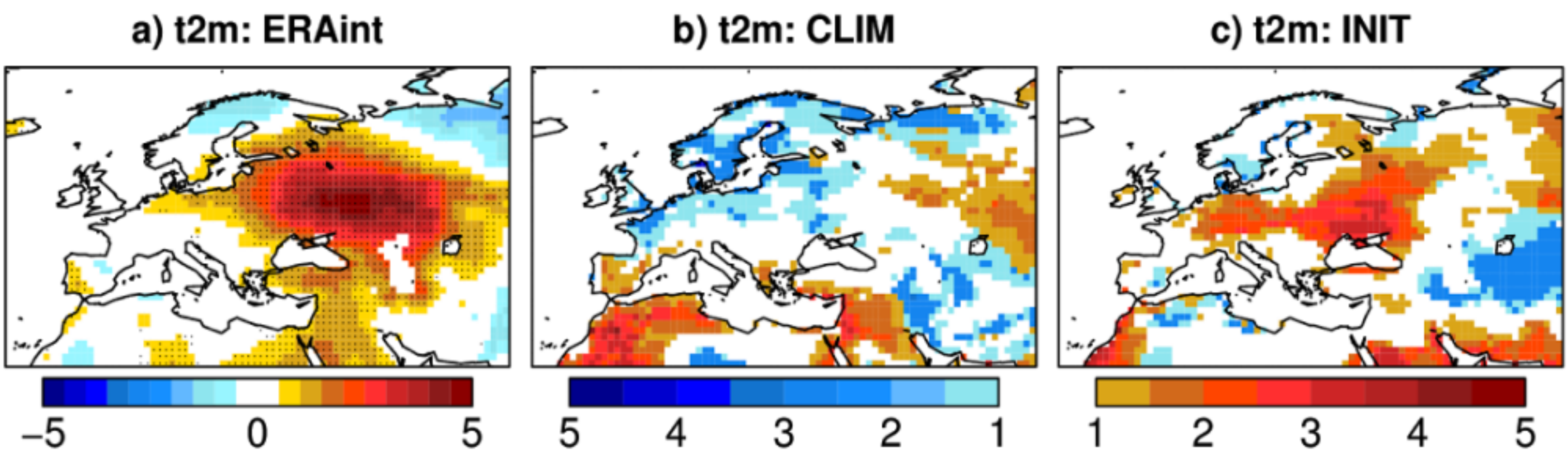
Bias from EC-Earth3.1 seasonal hindcasts (1993-2009, Glorys2v1, ERAInt and ERALand initial conditions).



Prodhomme et al. (2016, J. Climate)

Improving initialisation

JJA near-surface temperature anomalies in 2010 from ERAInt (left) and odds ratio from experiments with a climatological (centre) and a realistic (right) land-surface initialisation. Results for EC-Earth2.3 started in May with initial conditions from ERAInt, ORAS4 and a sea-ice reconstruction over 1979-2010.

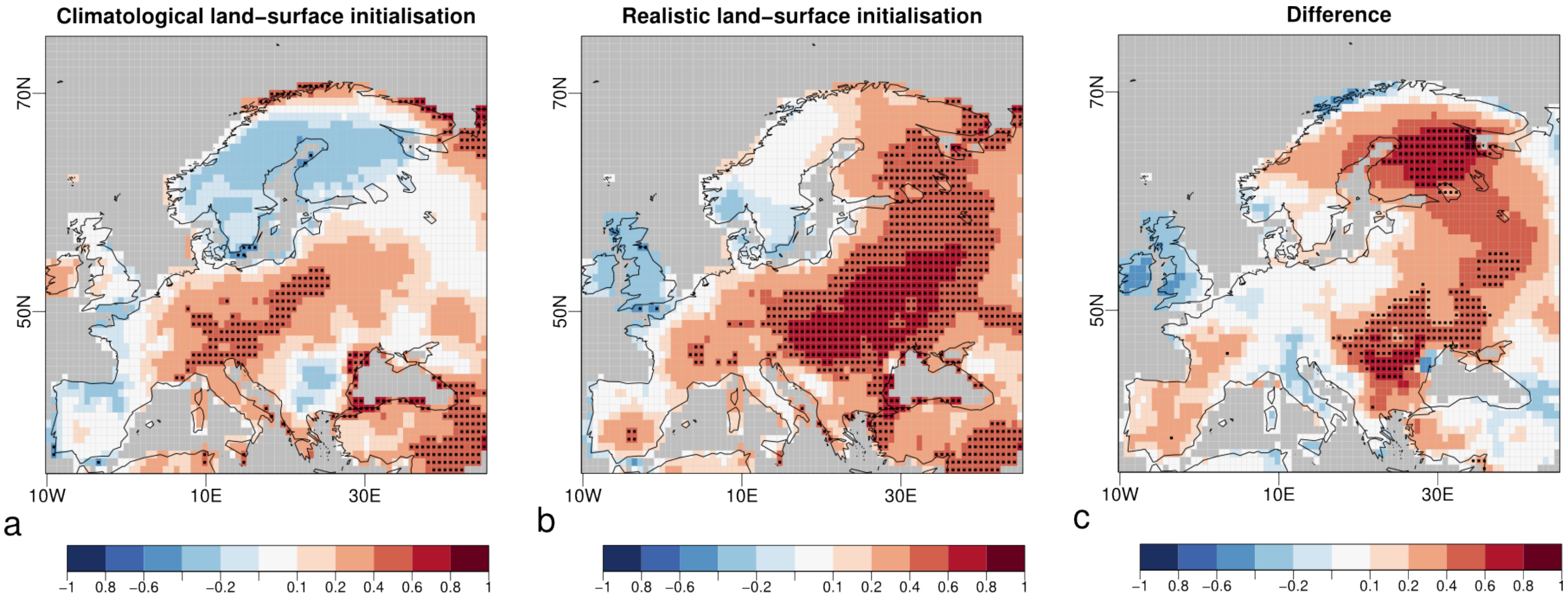


Prodhomme et al. (2015, Clim. Dyn.)

Sensitivity experiments at HR

Correlation of JJA near-surface temperature from EC-Earth3.1 hindcasts started in May over 1993-2009 with climatological (left) and ERA-Land (centre) land-surface initial conditions, and their difference (right).

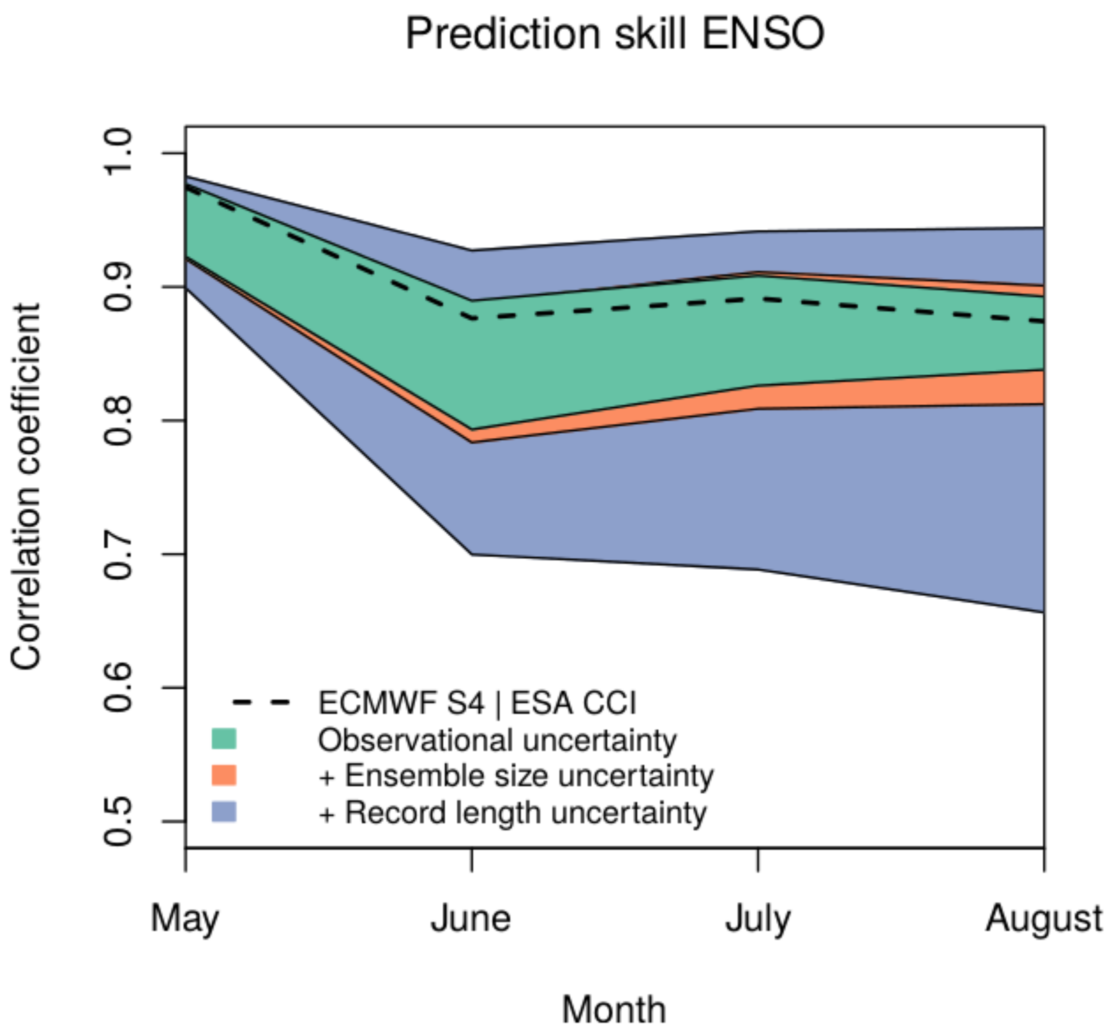
Hard to detect differences in sensitivity experiments: use of the Steiger test for correlation differences (increased power).



Siegert et al. (2017, MWR)

Observational uncertainty

Niño3.4 SST correlation of the ensemble mean for ECMWF System 4 started every May over 1993-2010.

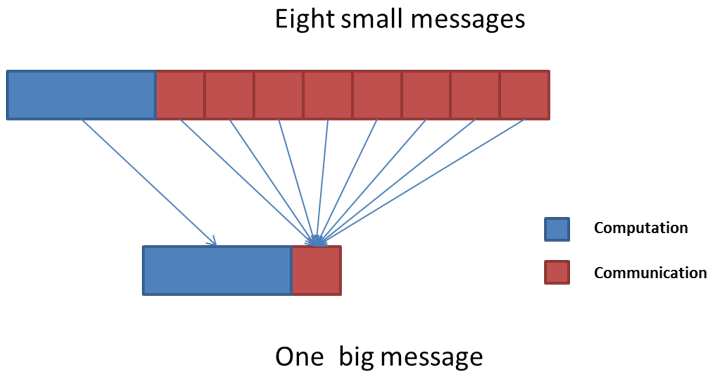


Bellprat et al. (2017, Rem. Sens. Env.)

Computational efficiency

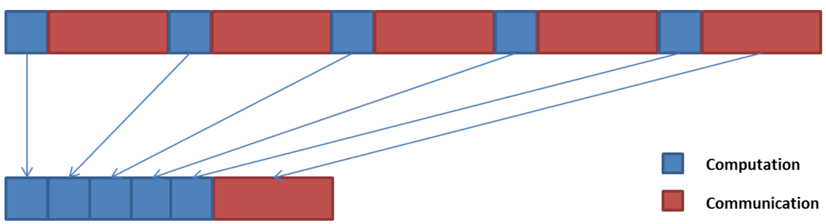
MPI message packing

Taking in account that NEMO is really sensitive to latency, messages aggregation is the best way to reduce the time invested in communications. Therefore, consecutive messages have been packed wherever the computational dependencies allow to do so.



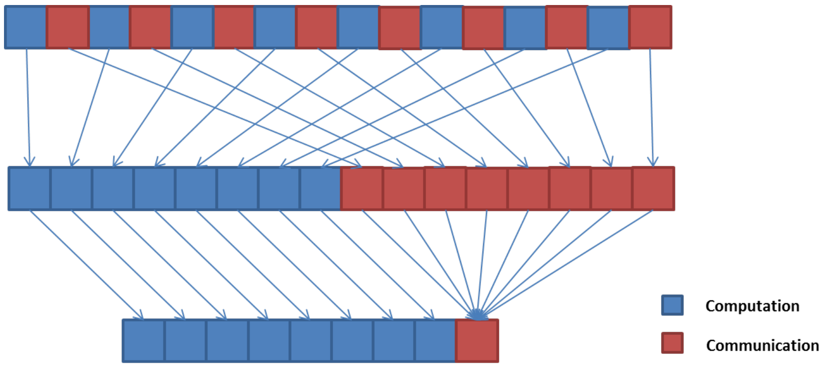
Convergence check reduction

Some routines use collective communications to perform a convergence check in iterative solvers. The cost of this verifications is really high, reaching a 66% of the time. Wherever the model allowed it, we reduced the frequency of this verifications in order to increase parallel efficiency.



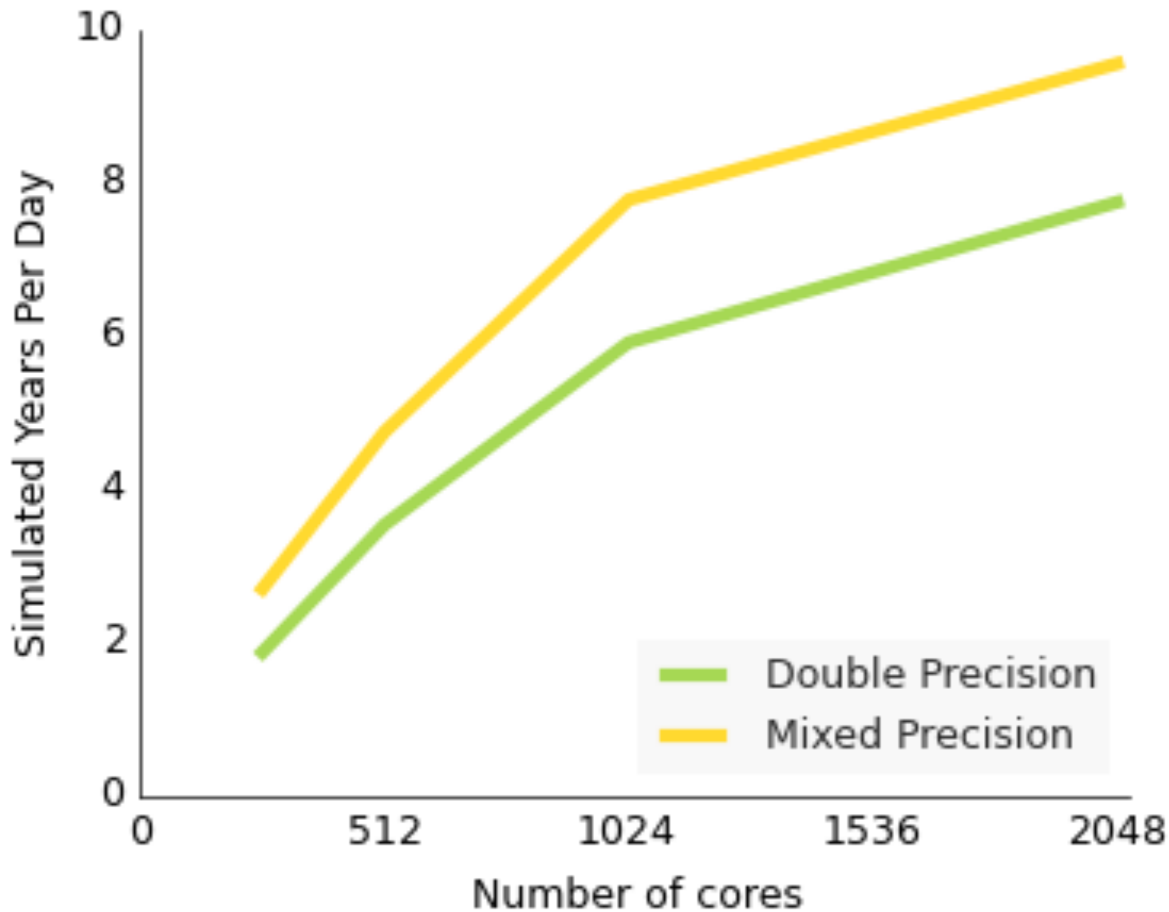
Reordering

In order to apply the message packing optimization to as many routines as possible, it was necessary to rearrange some computation and communication regions, taking into account the dependencies between them, to reduce the number of messages. This way it was possible to compute (and communicate) up to 41 variables at the same time, resulting in a dramatic reduction of the granularity.



Computational efficiency

Speed up of the NEMO3.6 (ORCA025L75) code when switching some parts of the code from double to single precision.

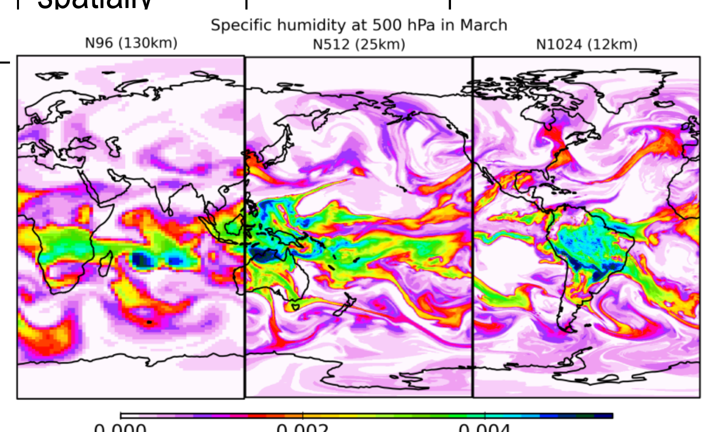


O. Tintó, M. Castrillo (BSC)

PRIMAVERA: A HR EU concerted effort

Aims to develop advanced and well-evaluated high-resolution global climate models, capable of simulating and predicting regional climate with unprecedented fidelity (contribution to HiResMIP).

Institution	MO NCAS	KNMI BSC SMHI CNR	CERFACS	MPI	AWI	CMCC	ECMWF
Model names	MetUM NEMO	ECEarth NEMO	Arpege NEMO	ECHAM MPIOM	ECHAM FESOM	CCESM NEMO	IFS NEMO
Atmosph. Res., core	60-25km	T255-799	T127-359	T63-255	T63-255	100-25km	T319-799
Atmosph. Res., FCM	10-5km						T1279-2047
Oceanic Res., core	¼°	¼°	¼	0.4-¼°	1-¼ spatially variable	¼	¼
Oceanic Res., FCM	1/12°	1/12°	1/12°	1/10°	1-1/14° spatially	*(1/16°)*	



Summary and some thoughts

- **Progress**: increased resolution improves both mean climate and skill for some areas and variables; further improvements require substantial experimentation for the model to be diagnosed at the same level as with the standard resolution configuration.
- **Challenges**: reference uncertainty, observations at equivalent resolutions, process understanding, leveraging knowledge from other communities (climate modelling and weather forecasting), etc.
- **Technology**: make the most of a context with rapidly evolving technology (heterogeneous nodes, software, mobile data capture, visualisation, storage/compression, computing and storage outsourcing) to reduce the model cost and increase the capability to experiment with expensive configurations.
- **Services**: who benefits from these expensive efforts?